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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	
Yuzu HIRAYAMA et al.	Group Art Unit: 2629
Application No.: 10/614,195	Examiner: Seokyun MOON
Filed: July 8, 2003	
For: 3D IMAGE REPRODUCTION APPARATUS	Confirmation No.: 6325

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

PERFECTION OF CLAIM FOR PRIORITY

On July 8, 2003, Applicant claimed priority to and filed a certified copy of JP 2002-198753 ("the Priority Document"). To perfect priority, Applicant hereby submits an English language translation of the Priority Document, as well as a statement that the translation is accurate.

Respectfully submitted,

FINNEGAN, HENDERSON, FARABOW,
GARRETT & DUNNER, L.L.P.

Dated: March 14, 2008

By: ~~Richard V. Burgujian~~ Reg. No. 58,997
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Attachments:
English Language Translation of JP 2002-198753 (38 pages); and
Statement that the Translation is Accurate (1 page)

TRANSLATION

I, Yuko Mitsui, residing at 4-6-10, Higashikoigakubo, Kokubunji-shi, Tokyo, Japan, state:

that I know well both the Japanese and English languages,

that I translated, from Japanese into English, Japanese Patent Application No. 2002-198753, filed on July 8, 2002, and

that the attached English translation is a true and accurate translation to the best of my knowledge and belief.

Dated: March 6, 2008

Yuko Mitsui

Yuko Mitsui

[Name of Document] PATENT APPLICATION

[Reference Number] A0000202608

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[To] Commissioner, Patent Office

[International Patent Classification] G03C 09/08

[Title of the Invention] 3D IMAGE REPRODUCTION APPARATUS

[Number of Claims] 3

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[Name] Shoji Kawai

[Indication of Official Fee]

[Prepayment Register Number] 011567

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[List of Items Submitted]

[Name of Item] Specification 1

[Name of Item] Drawing 1

[Name of Item] Abstract 1

[Necessity of Proof] Necessary

[Document] SPECIFICATION

[Title of the Invention] 3D IMAGE REPRODUCTION APPARATUS

[What is Claimed is:]

[Claim 1]

A 3D image reproduction apparatus comprising display means for displaying synthesis parallax images forming a 3D image by use of a plurality of arrayed sub regions, and an array plate which is arranged opposed to the display means and in which a plurality of pinholes or microlenses are arrayed in correspondence with the sub regions, wherein the 3D image is reproduced by which light emerged from the synthesis parallax images displayed on the displayed means is output through the array plate, the apparatus characterized in that

the sub regions correspond to pixels comprised of at least three sub pixels different in color, and

the sub pixels are laid out so that adjacent sub pixels differ in color.

[Claim 2]

The 3D image reproduction apparatus according to claim 1, characterized in that each of the sub pixels has a rectangular shape long in the vertical direction, and sub pixels of different colors are laid out to be adjacent to each other while sharing the sides of the rectangles.

[Claim 3]

The 3D image reproduction apparatus according to claim 1 or 2, characterized by comprising a plurality of slits or a lenticular sheet in place of the plurality of pinholes or microlenses.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a 3D image reproduction apparatus which reproduces a 3D image of an object.

[0002]

[Prior Art]

Three-dimensional display is assumed to be used in various fields such as amusements, Internet shopping, portable terminals, medical cares, virtual reality, and advertising display. Research and development in this field are progressing ever. As a method that makes 3D display possible, a stereoscopic method of displaying 2D images for left and right eyes on a display is known. The stereoscopic method allows an observer to see a 3D vision assuming that he/she observes the 2D image for the right eye with only his/her right eye and the 2D image for the left eye with only his/her left eye.

[0003]

In the stereoscopic method, the observer must put on, e.g., deflecting glasses such that he/she can observe the 2D image for the right eye with only his/her right eye and the 2D image for the left eye with only his/her left eye. The stereoscopic method produces a 3D vision with a limit observation direction. This method cannot reproduce a 3D image in consideration of observation from multiple directions. For example, even when the observer looks at the side or upper surface of the displayed image, no image

corresponding to the direction is displayed. It lacks sense of reality.

[0004]

Additionally, in the stereoscopic method, the focal point is located on the display surface. A spatial shift is generated between the focal point and a convergent position where the object of gaze is present. Since so-called mismatch between focus adjustment and convergent distance occurs, the observer easily feels sense of incompatibility for the reproduced space and becomes fatigued.

[0005]

As a 3D image display method that solves the above problems, a method of forming and reproducing a 3D image using many parallax images is disclosed in, e.g., Jpn. Pat. Appln. KOKAI Publication No. 10-239785 or 2001-56450. This method is known as an integral photography method.

[0006]

An "integral photography method" is based on almost the same principle as that of a light beam reproduction method, although its strict meaning as a 3D image display method is not accurately established yet. For example, a method using a pinhole array plate has been known for a long time as integral photography. The method is also sometimes called a light beam reproduction method. In the following explanation, the term "integral photography method" is used as a general term that conceptually includes the beam reproduction method.

[0007]

FIG. 15 is an example of a conventional 3D image

reproduction apparatus applying the integral photography method, which is viewed from a side. As is illustrated, a natural 3D image can be reproduced by a simple optical system configured by a display unit 1201 formed from, e.g., a liquid crystal display and an array plate 1202 having pinholes that are two-dimensionally arrayed.

[0008]

On the display unit 1201, a plurality of patterns (which are called multi-viewpoint images) are displayed in correspondence with each individual pinhole. The multi-viewpoint images construct synthesis parallax images whose appearances delicately change in accordance with the viewing angle from an observer. Lights emerging from the multi-viewpoint images pass through corresponding pinholes and converged, thereby forming a real image 1204 having a spatial 3D region in front of an array plate 1202. This is a display principle of the 3D image by the integral photography method.

[0009]

As illustrated in FIG. 15, parallax image light beams which emerge from the multi-viewpoint images on the display unit 1201 and propagate to an observer 1205 passing through the pinholes of the array plate 1202 are converged to form the real image 1204. At the same time, a 3D virtual image 1203 is also formed. As is explained above, in the integral photography method, a natural 3D image can be formed using a simple arrangement. In addition, no polarizing glasses are necessary, and a 3D image corresponding to a spatial 3D region is reproduced. For this reason, when the observer changes the

observation direction, the 3D image that the observer is seeing also changes in accordance therewith. Hence, a 3D image with more reality than 3D vision by the stereoscopic method can be reproduced.

[0010]

The amount of a light beam emerging from each point of a reproduced 3D image, i.e., the parallax information amount is determined by the number of multi-viewpoint images corresponding to respective pinholes. That is, when the number of multi-viewpoint images is increased, a natural motion parallax can be obtained. The number of pinholes means the number of 2D pixels of the 3D image. To reproduce an accurate 3D image having a natural motion parallax, a high-resolution display is necessary as an image display device. Liquid crystal displays (LCDs) whose resolution considerably increases recently are used as such image display devices.

[0011]

In a normal color liquid crystal display, three primary colors of R, G, and B (sub pixels) are spatially laid out, and other colors are displayed by spatial color mixture. In such a liquid crystal display using sub pixels of three primary colors of R, G, and B, the resolution greatly decreases in the display for 3D image reproduction than in non-3D image display.

[0012]

For example, assume that a liquid crystal display having a resolution of XGA (Extended Graphics Array: number of

pixels; 1024 × 768, and pixel pitch; 150 μm) is applied to a 3D image reproduction apparatus. When the number of horizontal light beams per pinhole is 10, the number of horizontal pixels is 102, and the pixel pitch is 1.5 mm, resulting in a coarse image. This problem of resolution, which is unique to 3D image reproduction, is required to be solved.

[0013]

[Object of the Invention]

The present invention aims to provide a 3D image reproduction apparatus which can deal with a problem caused in reproduction of a 3D image using, e.g., an color liquid crystal display with the RGB system, in which the resolution decreases in the display compared to the reproduction in non-3D image display, and which prevents so-called color flicker in sufficient RGB color mixture.

[0014]

[Means for Achieving the Object]

According to the present invention, there is provided a 3D image reproduction apparatus comprising display means for displaying synthesis parallax images forming a 3D image by use of a plurality of arrayed sub regions, and an array plate which is arranged opposed to the display means and in which a plurality of pinholes or microlenses are arrayed in correspondence with the sub regions, wherein the 3D image is reproduced by which light beams emerged from the synthesis parallax images displayed on the displayed means is output through the array plate, the apparatus characterized in that

the sub regions correspond to pixels comprised of at least three sub pixels different in color, and the sub pixels are laid out so that adjacent sub pixels differ in color.

[0015]

Additionally, the following configuration of the 3D image reproduction apparatus is also allowable: each of the sub pixels has a rectangular shape long in the vertical direction, and sub pixels of different colors are laid out to be adjacent to each other while sharing the sides of the rectangles.

[0016]

(Operational functions)

With the above-described constitution of the present invention, the pixel density in the horizontal direction can be increased. Simultaneously, the pixel density in the vertical direction can be prevented from excessively decreasing. In addition, color flicker can almost completely be suppressed since picture elements of different colors get into the observer's eye as the eyepoint moves in the horizontal direction. Further, even when the observer who is standing still gazes at the image, since light beams getting into the observer's right eye and left eye are generally of different colors, color flicker can almost completely be suppressed.

[0017]

A slit array or a lenticular sheet may be used in place of a plurality of pinholes or microlenses. In this case, parallax information in the vertical directions is positively abandoned. However, since the number of pixels in the

vertical direction increases, a reproduced image with high resolution can be obtained. This hardly allows the human eye to discriminate color separation in the image, achieving reproduction of a 3D image with extremely improved resolution.

[0018]

[Embodiments]

A 3D image reproduction apparatus according to the present invention will be described below in detail with reference to the accompanying drawings.

[0019]

(First Embodiment)

FIG. 1 is a view showing the schematic arrangement of a 3D image reproduction apparatus according to the first embodiment of the present invention. A liquid crystal display 1501 has a color liquid crystal display screen in which sub pixels of three primary colors of R, G, and B are two-dimensionally laid out in a matrix, as will be described later. The liquid crystal display 1501 is electrically driven by a driving unit 1505 to display parallax information in each row of the display screen. A backlight 1503 is arranged on the rear side of the liquid crystal display 1501. Light emitted from the backlight 1503 illuminates the display screen of the liquid crystal display 1501.

[0020]

A pinhole array plate 1502 is arranged on the opposite side of the backlight 1503, i.e., between an observer and the display screen of the liquid crystal display 1501. A 3D real image 1506 is reproduced by light beams emerging from pinholes

1509 of the pinhole array plate 1502 and recognized by an observing eye 1508. When the light beams are traced from the pinhole array plate 1502 in a direction reverse to the 3D real image 1506, a 3D virtual image 1507 can be reproduced. In addition, 3D images can be continuously reproduced in front and behind of the pinhole array plate 1502. A microlens array 1512 may be used in place of the pinhole 1509.

[0021]

The present embodiment has the following constitution in such a 3D image reproduction apparatus as described above so as to reproduce a natural 3D image having high resolution without any color flicker in RGB color mixture.

[0022]

FIG. 2 is a view showing the positional relationship between the 3D image reproduction apparatus shown in FIG. 1 and a 3D image, which is viewed from the upper side. The liquid crystal display 1501 arranged on the rear side of the pinhole array plate 1502 when viewed from the observer 1508 side displays synthesis parallax images, i.e., multi-viewpoint images whose appearances delicately change in accordance with the viewing angle from the observer 1508. Light beams emerging from the synthesis parallax images become a number of parallax image light beams through any of the pinholes 1509. The real image 1506 (3D image) is reproduced by focusing the light beams.

[0023]

In the liquid crystal display 1501 which two-dimensionally displays multi-viewpoint images, the minimum

driving unit is each of the sub pixels of R (red), G (green), and B (blue). A color can be reproduced by three sub pixels of R, G, and B.

[0024]

Each sub pixel displays the information of the luminance and color of a point at which a straight line that extends from the sub pixel through the center of the pinhole 1509 crosses the 3D image on the display space. Generally, there are a plurality of "points at which the 3D image crosses" a straight line that extends from a single sub pixel through a single pinhole 1509. However, a display point is defined as a point closest to the observer side. For example, referring to FIG. 2, a point P1 closer to the observing eye 1508 than a point P2 is defined as a display point.

[0025]

The display luminance value of each sub pixel is calculated by a method raytracing on the basis of the luminances of R, G, and B components for the point where the straight line that extends from the sub pixel through the center of the pinhole 1509 crosses the 3D image to be displayed. More specifically, in 24-bit color display, as the luminance of an R sub pixel, the R component (having a numerical value from 0 to 255) of a corresponding color value is used. As the luminance of a G sub pixel, the G component (having a numerical value from 0 to 255) of a corresponding color value is used. As the luminance of a B sub pixel, the B component (having a numerical value from 0 to 255) of a corresponding color value is used. Thus, the color of the 3D

image can be reproduced.

[0026]

FIG. 3 is a schematic front view of a pixel layout in the liquid crystal display of the 3D image reproduction apparatus shown in FIG. 1.

[0027]

As shown in FIG. 3, the sub pixel array has numbers (suffixes) in the horizontal and vertical directions. The numbers represent parallaxes (or viewpoints) corresponding to the sub pixel array. One sub pixel has a width of 50 μm and a length of 150 μm. In the horizontal directions, first to 10th parallaxes are assigned cyclically to the sub pixels. In the vertical direction, first to fifth parallaxes are assigned cyclically to the sub pixels.

[0028]

In this embodiment, the sub pixels are laid out on a regular basis in the liquid crystal display 1501, as shown in FIG. 3. Three sub pixels corresponding to a first red picture element (R), second green picture element (G), and third blue picture element (B) are laid out to be adjacent to each other while sharing their sides. In other words, sub pixels of the same picture element are not laid out adjacent to each other while sharing their sides. A color can be reproduced by the three sub pixels, i.e., the first red picture element (R), second green picture element (G), and third blue picture element (B).

[0029]

For the liquid crystal display 1501, when light beams

from the liquid crystal display 1501 are output through the pinhole array plate 1502 including the rectangular pinholes 1509 each having, e.g., a width of 50 μm and a length of 150 μm, as shown in FIG. 4, new light-emitting points can be formed by these light beams.

[0030]

According to this arrangement, the pixel density in the horizontal direction can be increased. Simultaneously, the pixel density in the vertical direction can be prevented from excessively decreasing. In addition, color flicker can almost completely be suppressed since picture elements of different colors get into the observer's eye as the eyepoint moves in the horizontal direction. Further, even when the observer who is standing still gazes at the image, since light beams getting into the observer's right eye and left eye are of different colors, color flicker can almost completely be suppressed.

[0031]

FIG. 5 is a view showing an arrangement having a slit array plate 1510 in place of the pinhole array 1502 of FIG. 1. FIG. 6 is a schematic front view of the slit array plate 1510. When the slit array 1510 is used, parallaxes in the vertical directions are positively abandoned. A slit array plate can more easily be manufactured than a pinhole array plate and can reproduce a natural high-resolution 3D image without any color separation, like a pinhole array plate. Note that a lenticular sheet 1513 may be used in place of the slit array plate.

[0032]

According to the first embodiment described above, the sub pixels of the three primary colors of R, G, and B, each of which has a rectangular shape, are arrayed with their longitudinal sides arranged in the vertical direction. For this reason, the pixel density in the horizontal direction can be increased as compared to a case where sub pixels of the three primary colors of R, G, and B, each of which has a square shape, are arrayed in the vertical direction to make pixel mapping long in the vertical direction.

[0033]

Color flicker due to insufficient RGB color mixture will be described here. Generally, color flicker becomes conspicuous when the pixel size is relatively large. For example, assume that light beams having desired colors and luminances are output from a liquid crystal display 1520 in which pixels (to be referred to as triplets) are formed by arraying R, G, and B sub pixels with their longitudinal sides arranged in the vertical direction, as shown in FIG. 7, through a slit array plate 1521 as shown in FIG. 8. In this case, since the R, G and B triplets are extremely long in the vertical direction, e.g., the longitudinal length of a pixel exceeds 500 μm, not the desired color but separate R, G, and B colors are observed.

[0034]

In the first embodiment having the layout shown in FIG. 3, however, the color flicker can be prevented.

[0035]

(Second Embodiment)

FIG. 9 is a view showing a liquid crystal display according to a second embodiment of the present invention. A liquid crystal display 1530 of the second embodiment is different from the liquid crystal display 1501 of the first embodiment in the pixel layout method, as is apparent from comparison with FIG. 3. The remaining points other than the pixel layout are the same as in the first embodiment. In the layout shown in FIG. 3, sub pixels of the same color are laid out in a diagonal pattern toward the lower right. In FIG. 9, however, sub pixels of the same color are laid out in a V-shaped pattern.

[0036]

Even in the pixel layout of the second embodiment as shown in FIG. 9, sub pixels of the same color are laid out not to be adjacent to each other while sharing their sides.

[0037]

When light beams are output through a pinhole array plate 1531 having rectangular pinholes each having a width of 50 μm and a length of 150 μm, as shown in FIG. 10, new light-emitting points can be formed by these light beams.

[0038]

According to the second embodiment, the number of light beams greatly increases, and a natural high-resolution 3D image can be reproduced without any color separation.

[0039]

FIG. 11 shows an arrangement in which a slit array plate

1532 is used in place of the pinhole array plate 1531 shown in FIG. 10 in correspondence with the pixel layout shown in FIG. 9. In this case, although vertical parallaxes are abandoned, a natural high-resolution 3D image can still be reproduced without any color separation.

[0040]

(Third Embodiment)

FIG. 12 is a view showing a liquid crystal display according to a third embodiment of the present invention. A liquid crystal display 1533 of the third embodiment is different from the liquid crystal display 1501 of the first embodiment and the liquid crystal display 1530 of the second embodiment in the pixel layout method, as is apparent from comparison with FIGS. 3 and 9. The remaining points other than the pixel layout are the same as in the first and second embodiments.

[0041]

When light beams are output through a pinhole array plate 1534 having rectangular pinholes each having a width of 50 μm and a length of 150 μm, as shown in FIG. 13, new light-emitting points can be formed by these light beams.

[0042]

Even according to the third embodiment, the number of light beams greatly increases, and a natural high-resolution 3D image can be reproduced without any color separation, as in the third embodiment.

[0043]

FIG. 14 shows an arrangement in which a slit array plate

1535 is used in place of the pinhole array plate 1534 shown in FIG. 13 in correspondence with the pixel layout shown in FIG. 12. In this case, although vertical parallaxes are abandoned, a natural high-resolution 3D image can still be reproduced without any color separation.

[0044]

The present invention is by no means limited to the foregoing embodiments and can be implemented by modifying in various ways. For instance, not the above-described liquid crystal display that constructs the display device, a spontaneous emission type display such as a plasma display or an organic EL (ElectroLuminescence) display may be used. In addition, the pixel layout is not limited to the above-described layouts. For example, the layout shown in FIG. 1 may be inverted in the horizontal direction.

[0045]

[Advantage of the Invention]

As has been described, according to the present invention, it is possible to provide a 3D image reproduction apparatus which can deal with a problem caused in reproduction of a 3D image using, e.g., an color liquid crystal display with the RGB system, in which the resolution decreases in the display compared to the reproduction in non-3D image display, and which prevents so-called color flicker in sufficient RGB color mixture.

[Brief Description of the Drawings]

[FIG. 1]

A view showing the schematic arrangement of a 3D image

reproduction apparatus according to a first embodiment of the present invention.

[FIG. 2]

A view showing the positional relationship between the 3D image reproduction apparatus and a 3D image, which is viewed from the upper side.

[FIG. 3]

A schematic front view of a pixel layout in a liquid crystal display of the 3D image reproduction apparatus shown in FIG. 1.

[FIG. 4]

A schematic front view of a pinhole array plate corresponding to the pixel layout shown in FIG. 3.

[FIG. 5]

A view showing an arrangement having a slit array plate in place of the pinhole array plate shown in FIG. 1.

[FIG. 6]

A schematic front view of the slit array plate corresponding to the pixel layout shown in FIG. 3.

[FIG. 7]

A view showing a pixel layout so as to explain color flicker in RGB color mixture.

[FIG. 8]

A view showing a slit array plate corresponding to the pixel layout shown in FIG. 7 so as to explain color flicker in RGB color mixture.

[FIG. 9]

A schematic front view of a pixel layout in a liquid

crystal display according to a second embodiment of the present invention.

[FIG. 10]

A schematic front view of a pinhole array plate combined with the pixel layout shown in FIG. 9.

[FIG. 11]

A view showing a slit array plate which is used in place of the pinhole array plate shown in FIG. 10 in correspondence with the pixel layout shown in FIG. 9.

[FIG. 12]

A schematic front view of a pixel layout in a liquid crystal display according to a third embodiment of the present invention.

[FIG. 13]

A schematic front view of a pinhole array plate corresponding to the pixel layout shown in FIG. 12.

[FIG. 14]

A view showing a slit array plate which is used in place of the pinhole array plate shown in FIG. 13 in correspondence with the pixel layout shown in FIG. 12.

[FIG. 15]

A view for explaining a conventional 3D image reproduction apparatus.

[Explanation of Reference Symbols]

1501: Liquid crystal display

1502: Pinhole array plate

1503: Backlight

1504: Backlight power supply

1505: Driving unit

1506: Reproduced 3D real image

1507: Reproduced 3D virtual image

1508: Observing eye

1509: Pinhole

1511: Slit

1512: Microlens array

1513: Lenticular sheet

1510: Slit array plate

1520: Liquid crystal display

1521: Slit array plate

1530: Liquid crystal display

1531: Pinhole array plate

1532: Slit array plate

1533: Liquid crystal display

1534: Pinhole array plate

1535: Slit array plate

1201: Liquid crystal display

1202: Pinhole array plate

1203: 3D real image

1204: 3D virtual image

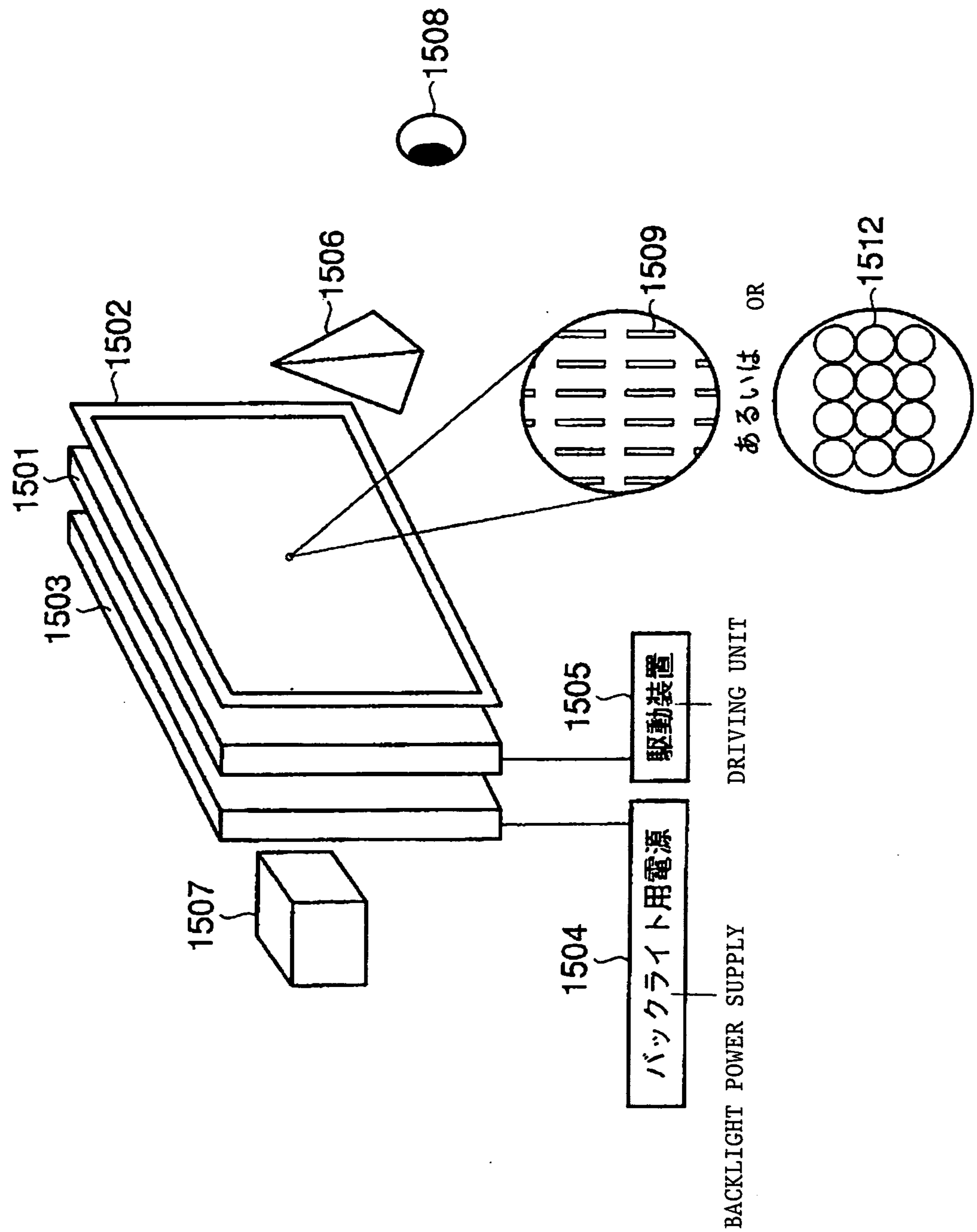
1205: Observing eye

NAME OF DOCUMENT

【書類名】　　　　図面—DRAWINGS

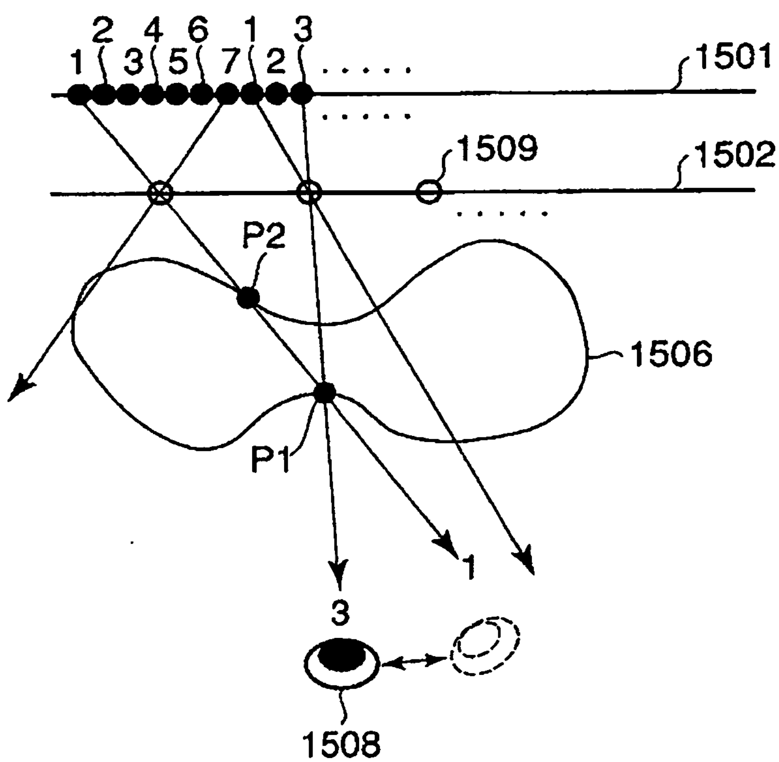
【図１】

FIG. 1



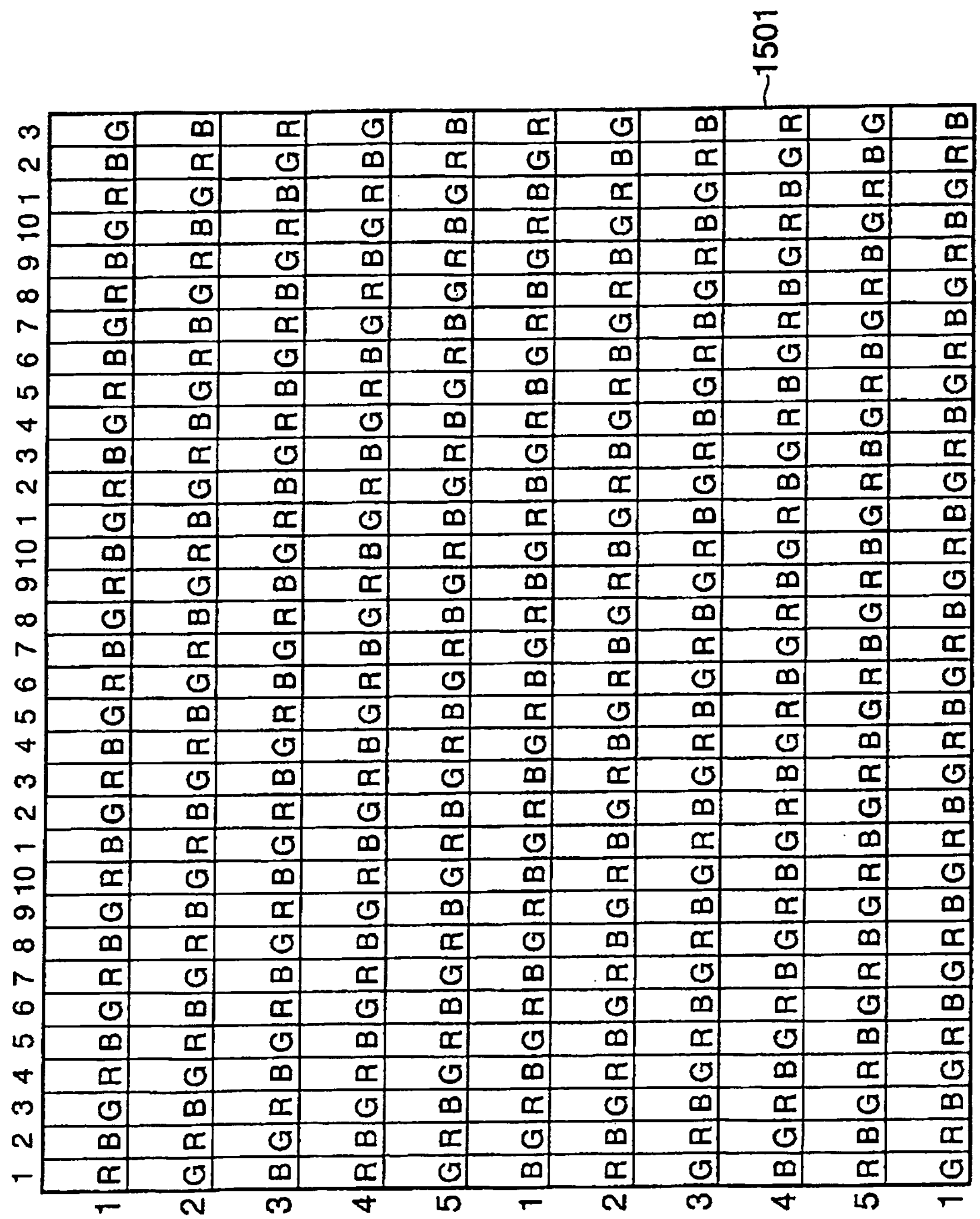
【図2】

FIG. 2



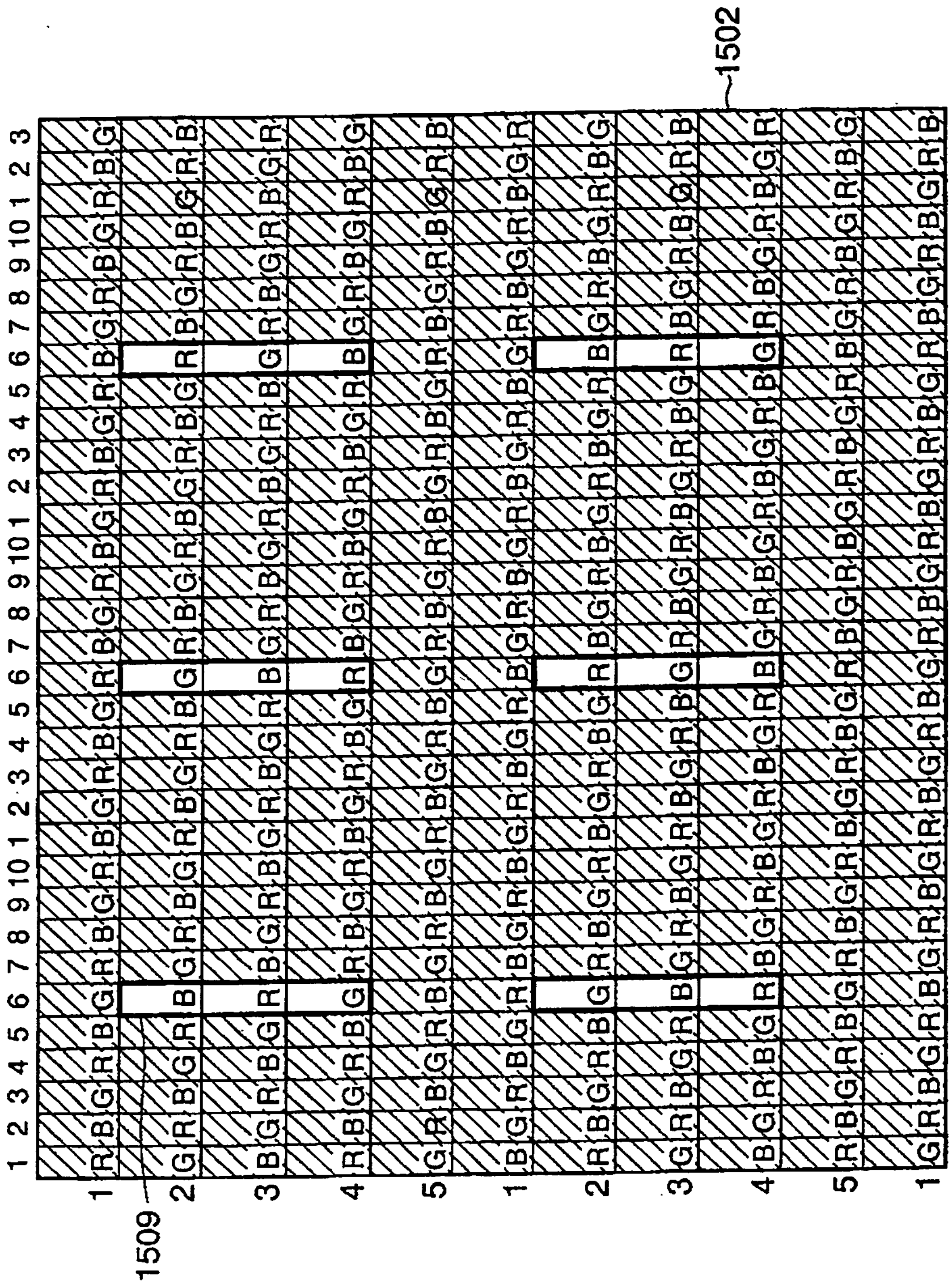
【図3】

FIG. 3

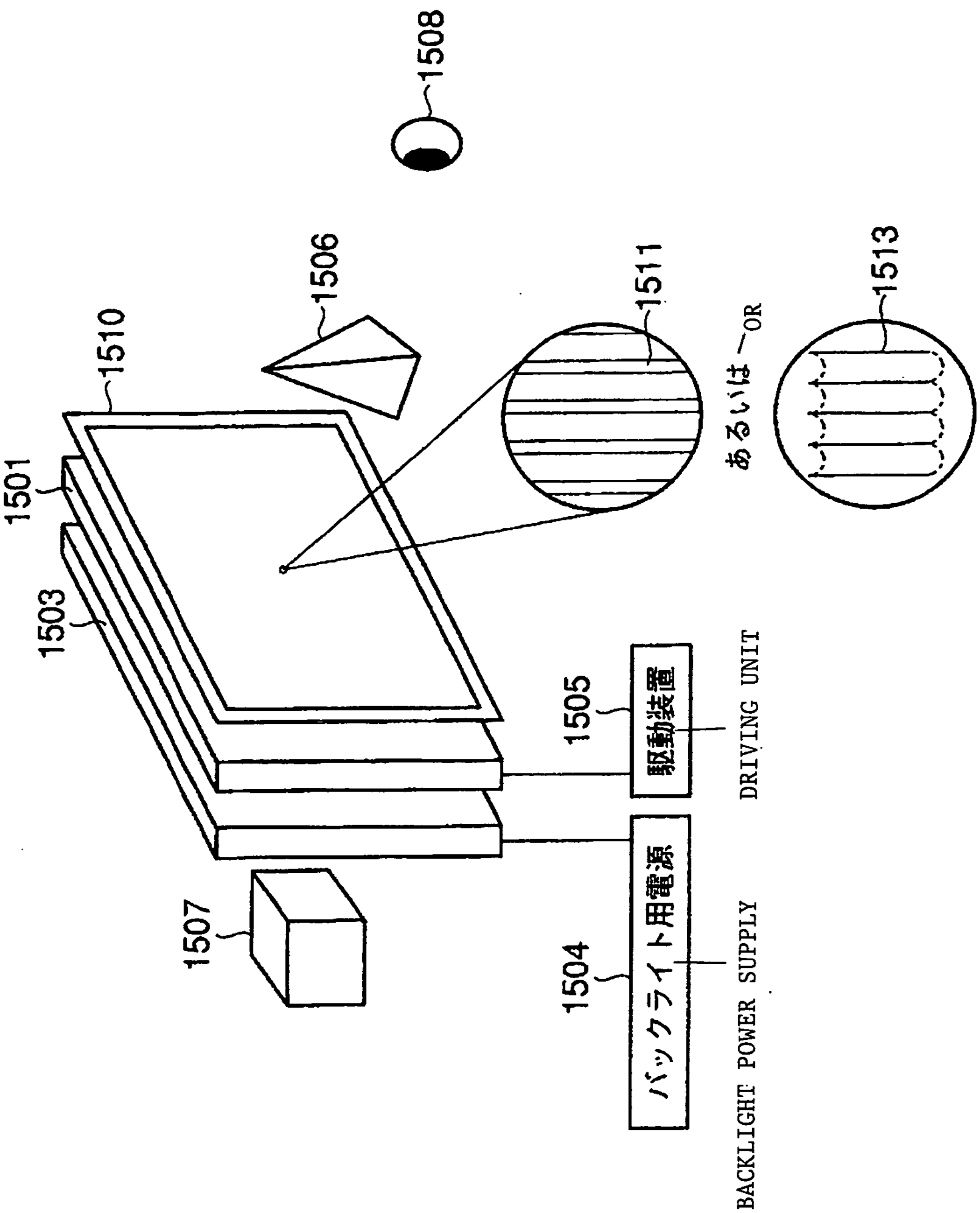


【図4】

FIG. 4



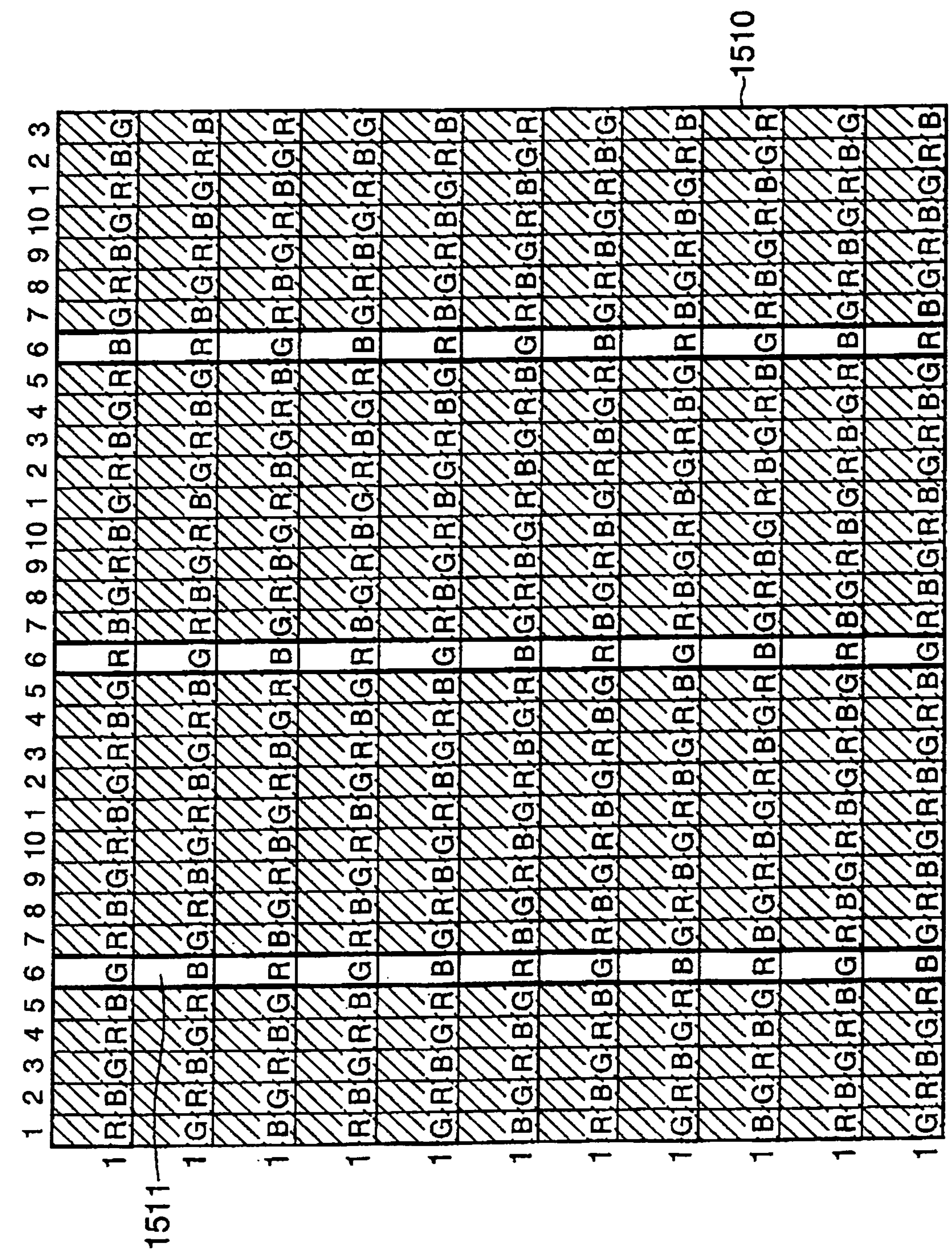
【図5】
FIG. 5



1508
1506
1510
1511
1501
1503
あるいは
OR
1513
1505
駆動装置
DRIVING UNIT
1507
1504
バックライト用電源
BACKLIGHT POWER SUPPLY

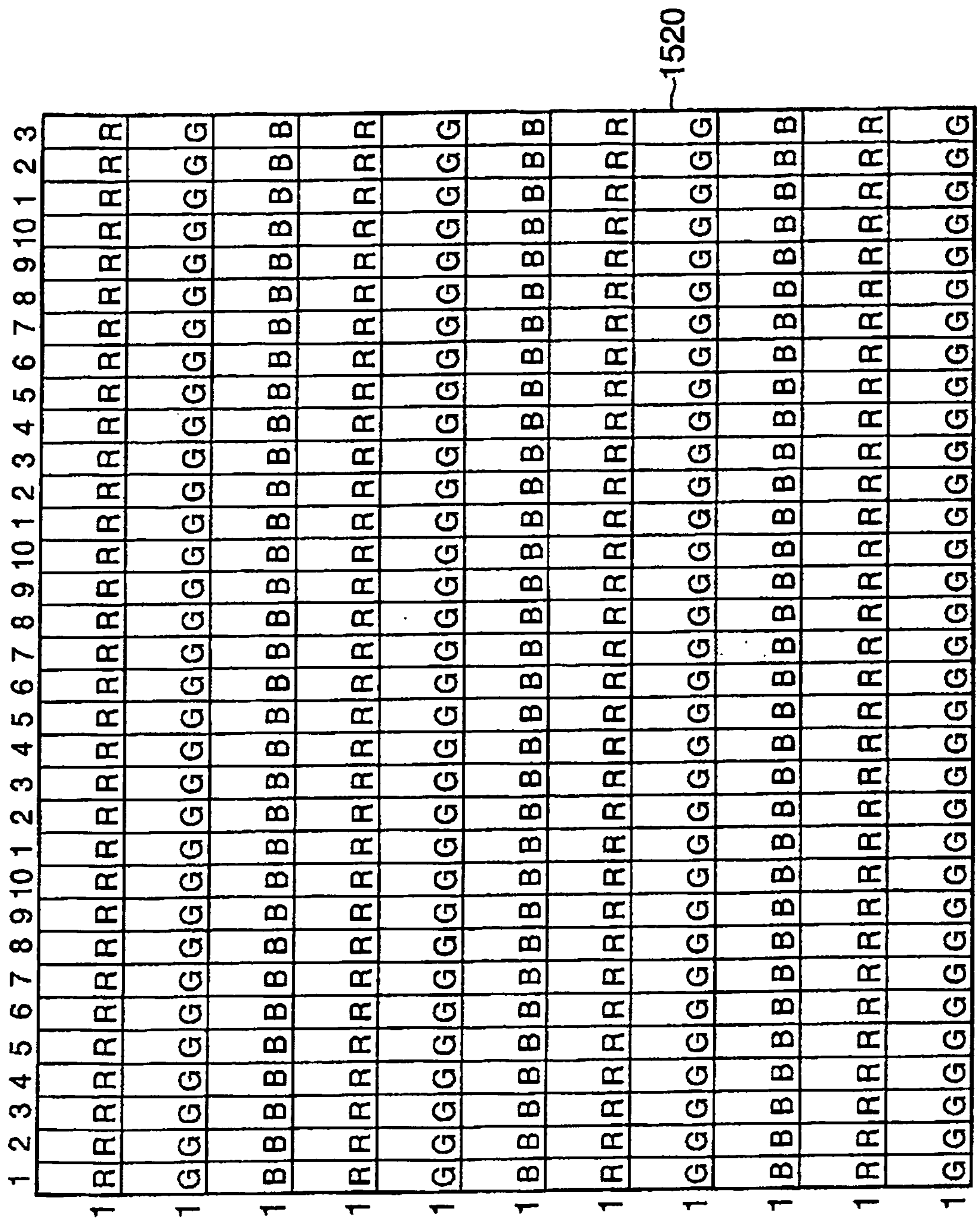
【図6】

FIG. 6

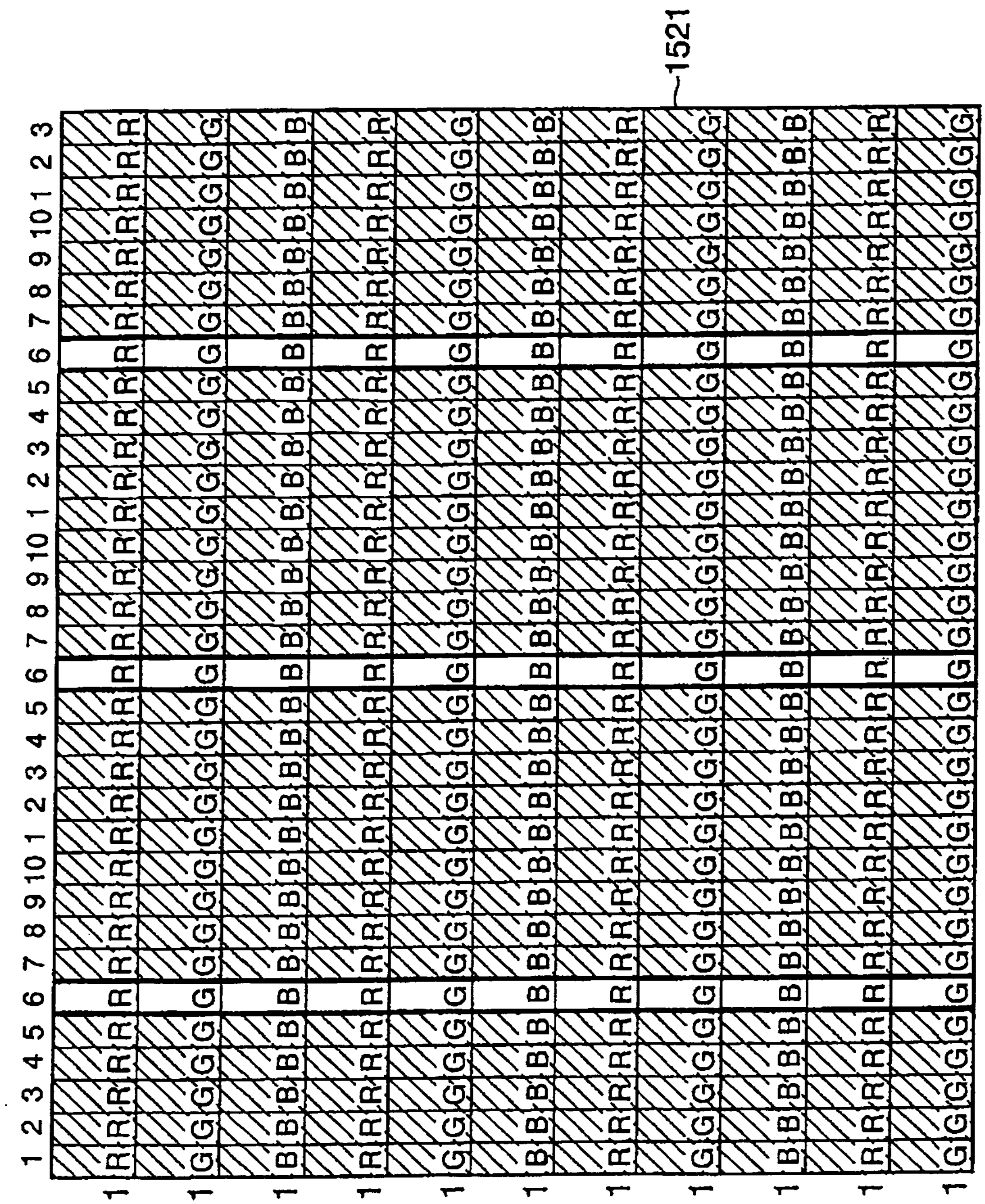


【図7】

FIG. 7

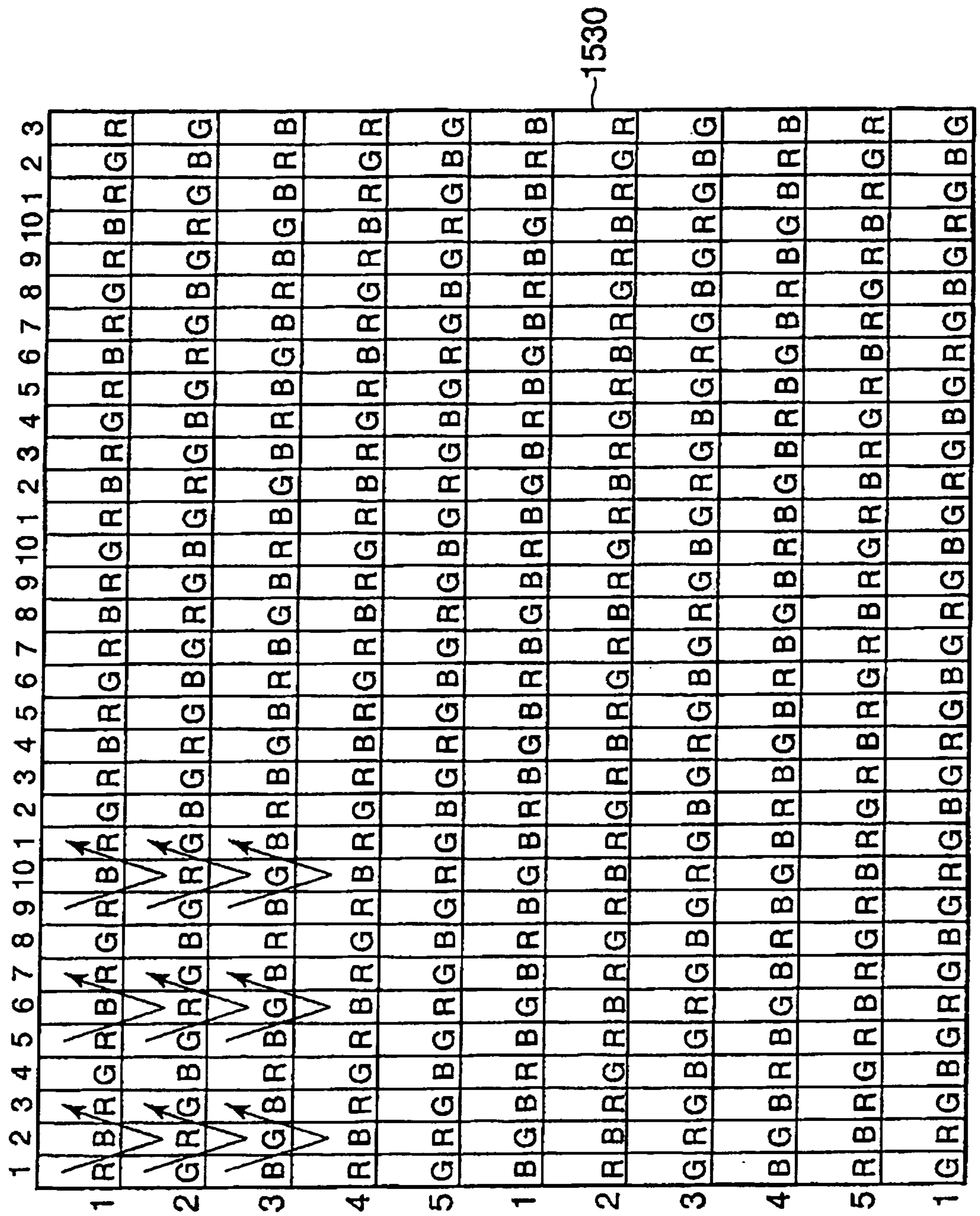


【図8】
FIG. 8



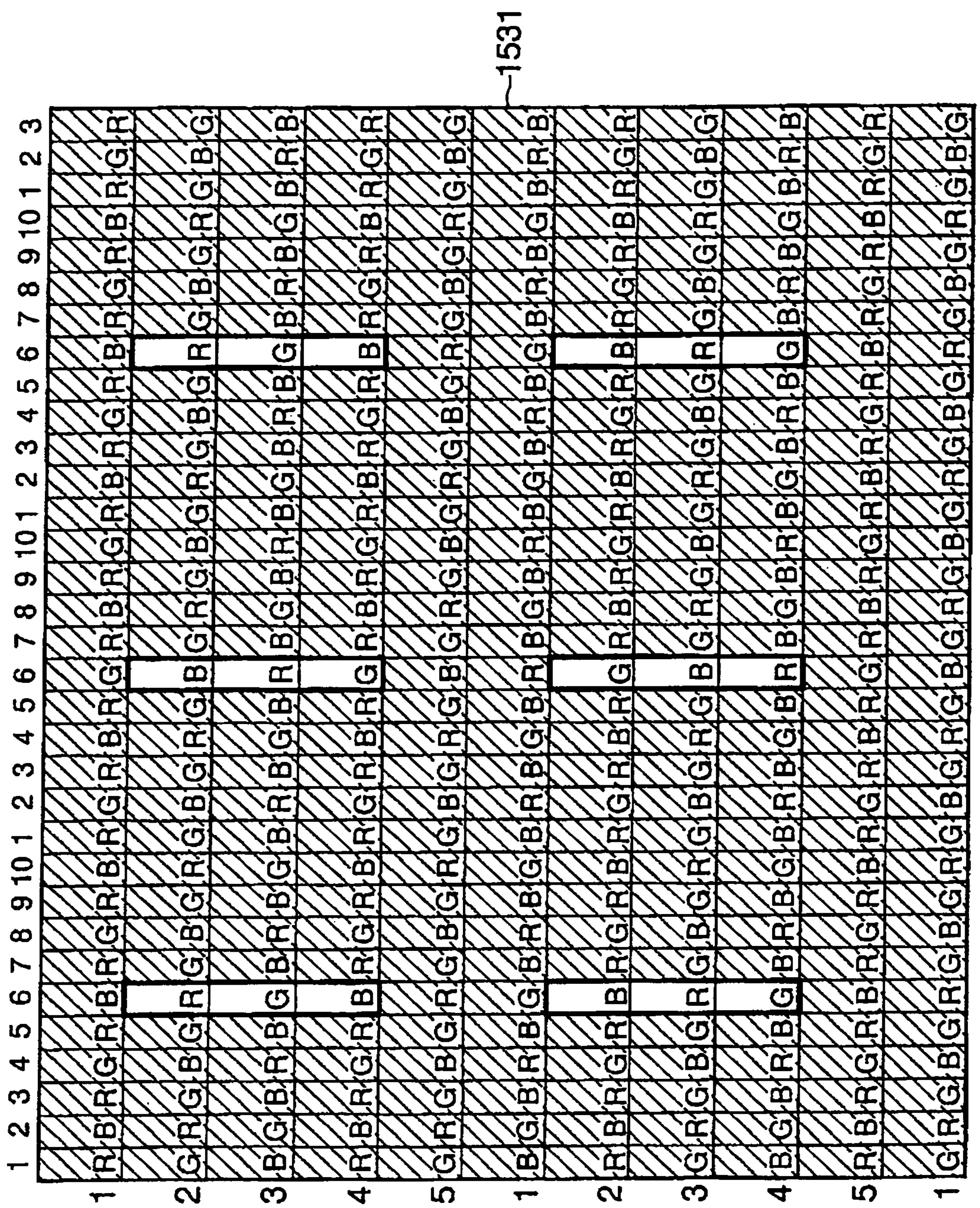
【図9】

FIG. 9

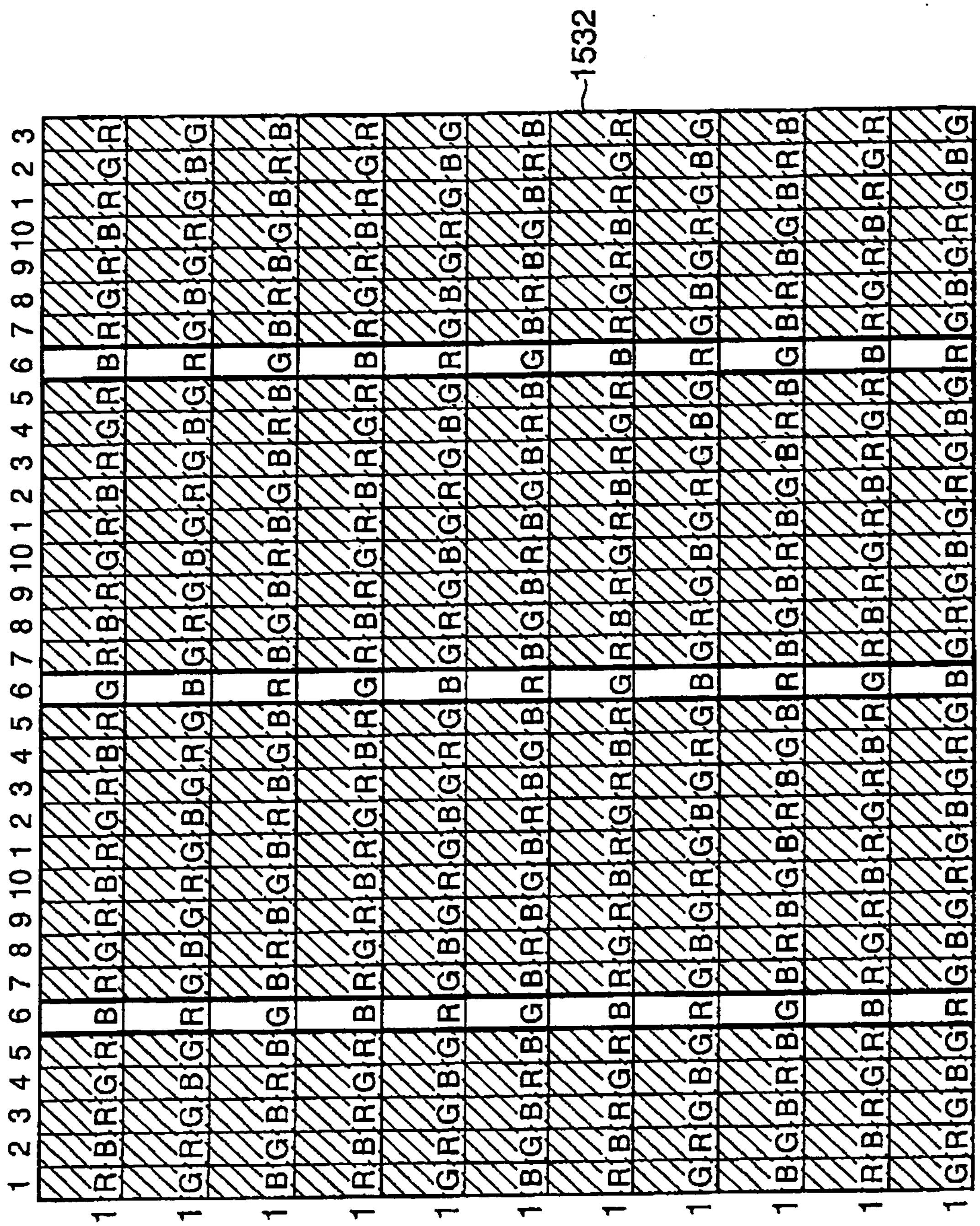


【図１０】

FIG. 10

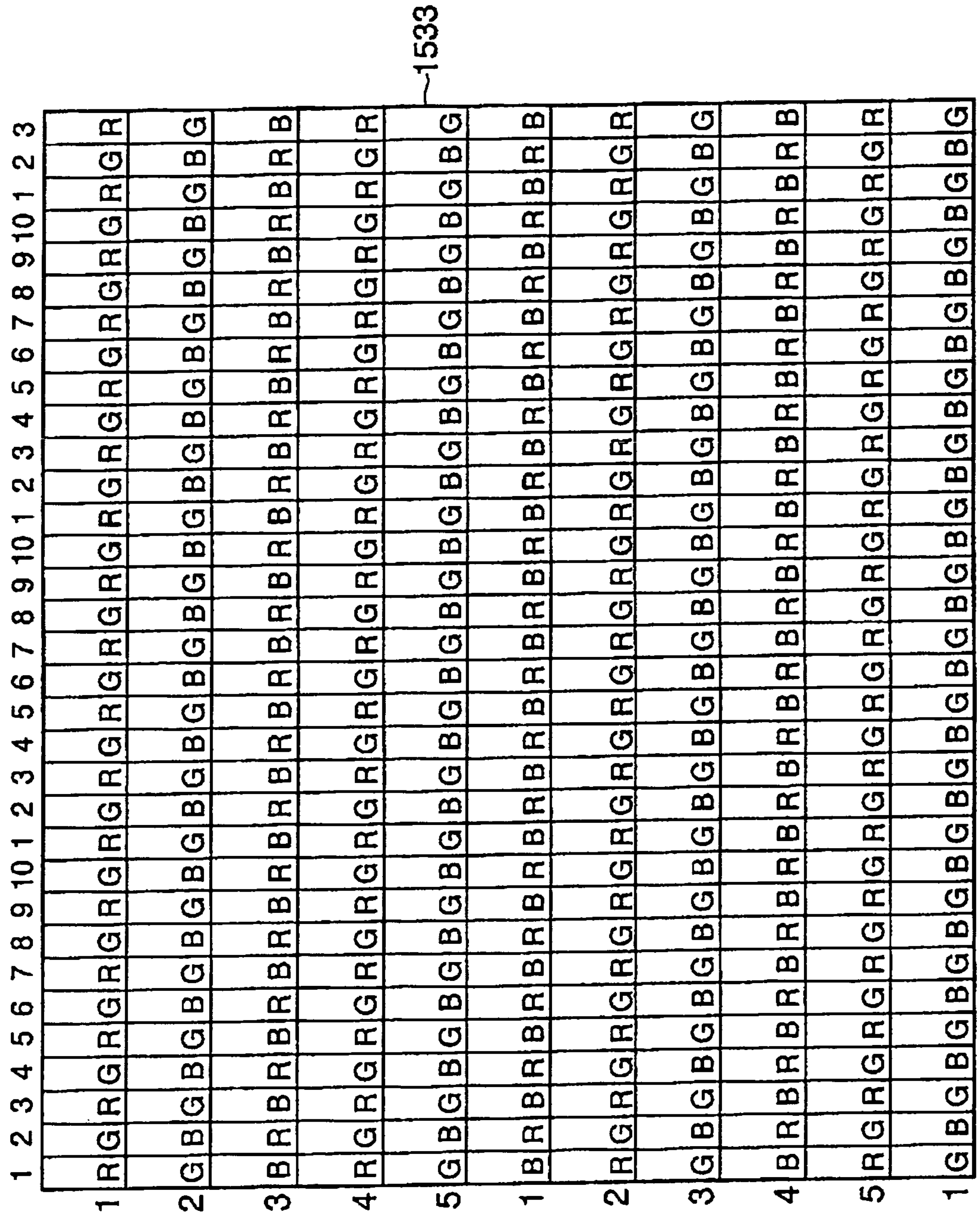


【図１１】
FIG. 11



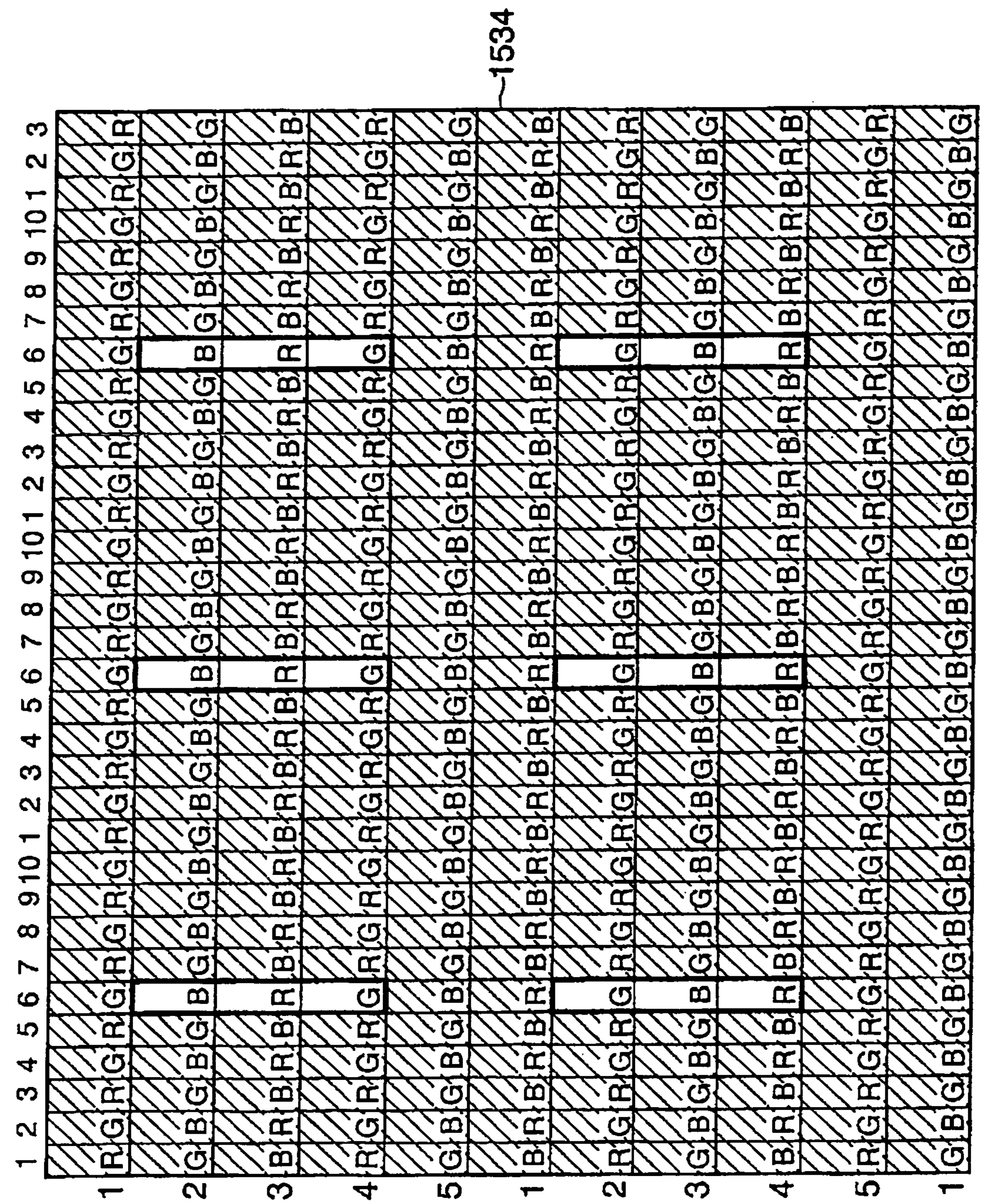
【図１２】

FIG. 12

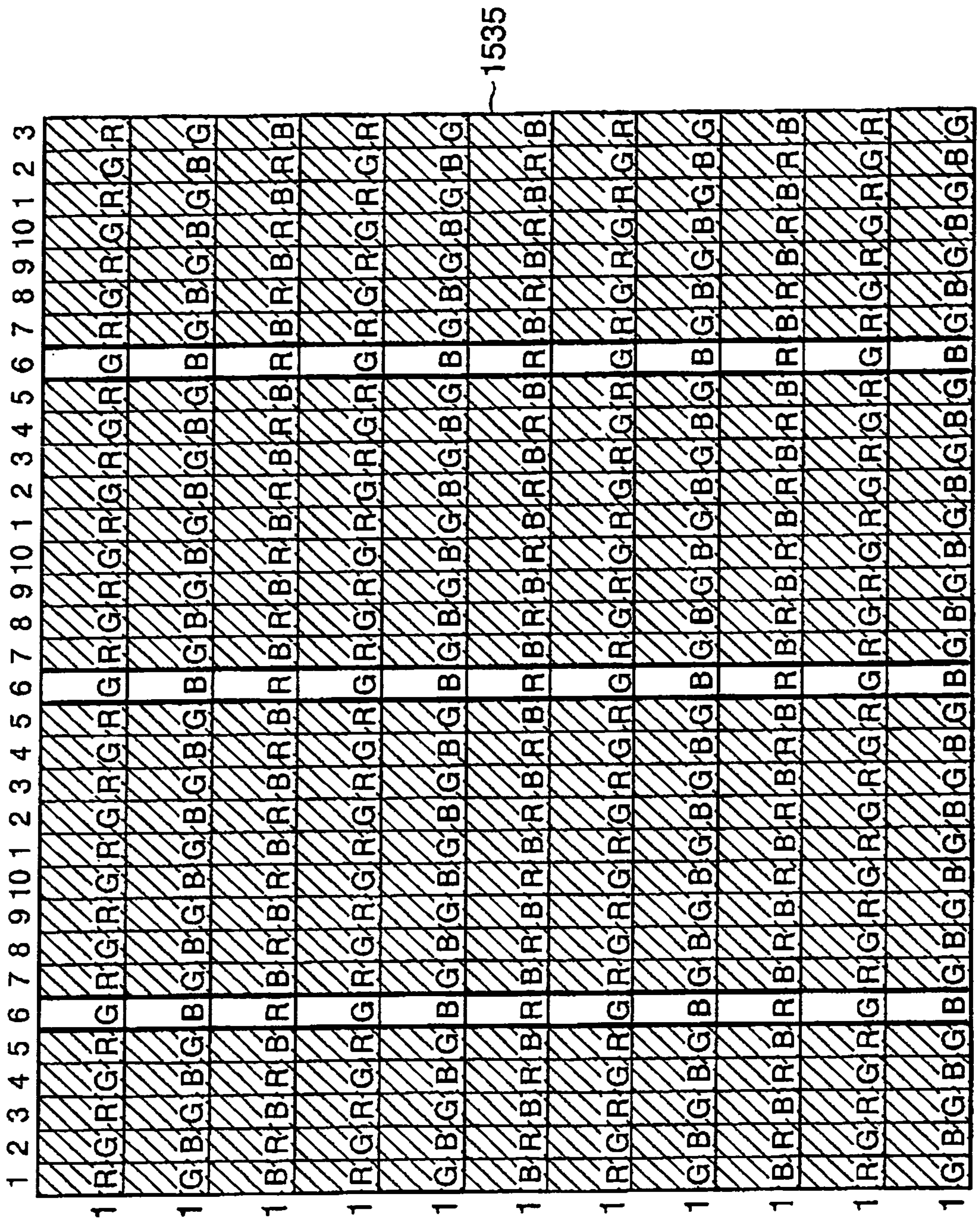


【図１３】

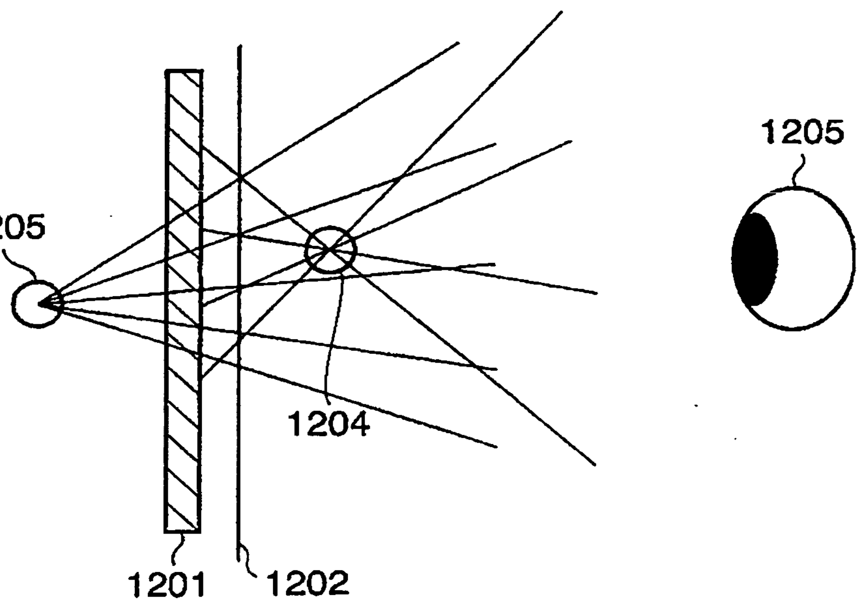
FIG. 13



【図１４】
FIG. 14



【図１５】
FIG. 15



[Document] ABSTRACT

[Abstract]

[Object] To provide a 3D image reproduction apparatus which can reproduce a 3D image with improved resolution without any color flicker in RGB color mixture.

[Means for Achieving the Object] A 3D image reproduction apparatus comprising display means for displaying synthesis parallax images forming a 3D image by use of a plurality of arrayed sub regions, and an array plate which is arranged opposed to the display means and in which a plurality of pinholes or microlenses are arrayed in correspondence with the sub regions, in which the 3D image is reproduced by which light beams emerged from the synthesis parallax images displayed on the displayed means is output through the array plate, the sub regions corresponding to pixels comprised of at least three sub pixels different in color, and the sub pixels being laid out so that adjacent sub pixels differ in color.

[Elected Figure] FIG. 1